DEC STD 102-2 Environmental Standard for Computers and Peripherals—Mechanical Shock and Vibration Test Requirements

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ABSTRACT: This standard establishes the levels of mechanical shock and vibration that Digital hardware products must be able to withstand. It defines environmental classifications and establishes the test requirements and conditions used to determine that products and associated shipping packages meet mechanical shock and vibration requirements.

APPLICABILITY: This standard is mandatory for Digital personnel responsible for products and associated shipping packages.

STATUS: APPROVED 03-Nov-1992; use VTX SMC for current status.

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1 INTRODUCTION

This standard establishes the levels of mechanical shock and vibration that Digital hardware products must be able to withstand. It defines environmental classifications and establishes the test requirements and conditions used to determine that products and associated shipping packages meet mechanical shock and vibration requirements.

1.1 SCOPE

This standard applies to hardware products designed, manufactured, or sold by Digital Equipment Corporation. Media subassemblies or media and associated hardware elements such as cassettes, cartridges, reels, disks, and floppies must be evaluated according to these requirements.

Subsequent applications of media subassemblies, such as for various software or diagnostic products, do not require additional testing unless the physical hardware element changes.

Manuals, books, and drawings must be tested in cases where they are shipped within the product packaging, but individual packages for these items need not be tested separately to these requirements.

1.2 RESPONSIBILITIES

For additional information about responsibilities, refer to *DEC STD 102-0 Environmental Standard for Computers and Peripherals — General Test Requirements*, subhead 1.3.

1.3 SHIPPING PACKAGE TESTING GUIDE

This standard requires the successful completion of the tests defined in heads 2 and 3.

The following paragraphs list the tests to be performed for each shipping package weight category. *NA* means not applicable.

1.3.1 Individual Shipping Packages

Weight Less Than 45 kg (100 lbs)

a. Vibration—Repetitive Shock requirements according to subhead 3.4.2 – 3 samples

b. Shock Drop[1] according to subhead 2.2.2—3 samples

c. Shock-Inclined Impact—NA

d. Random Vibration according to subhead 3.3.4—1 sample

e. Compression—Section To Be Determined (TBD)

f. Stability—NA

Weight 45 kg (100 lbs) to 113 kg (250 lbs) Skidded or Unskidded Packages

a. Vibration–Repetitive Shock according to subhead 3.4.3—3 samples

b. Shock Drop—NA

c. Shock-Inclined Impact[1] according to subhead 2.3.2.1—3 samples

[1] Vibration–Repetitive Shock tests must be performed prior to these shock tests.

d. Random Vibration according to subhead 3.3.4—1 sample

e. Compression—TBD

f. Stability according to *DEC STD 102-3 Physical Stability Requirements During Shipping and Handling*, subheads 3.5 or 3.6—1 sample

Weight Greater than 113 kg (250 lbs) Skidded or Packaged

a. Vibration–Repetitive Shock according to subhead 3.4.3—1 sample

b. Shock Drop–NA

c. Shock-Inclined Impact[1] according to subhead 2.3.2.2—1 sample

d. Random Vibration according to subhead 3.3.4—1 sample

e. Compression—TBD

f. Stability according to DEC STD 102-3, subhead 3.5 or 3.6—1 sample

1.3.2 Individual Skidded Items

Weight 28 kg (61 lbs) to 45 kg (100 lbs) Integral Skid

a. Vibration–Repetitive Shock according to subhead 3.4.2—3 samples

b. Shock Drop—NA

c. Shock-Inclined Impact[1] according to subhead 2.3.3.2—3 samples

d. Random Vibration according to subhead 3.3.3—1 sample

e. Compression—TBD

f. Stability according to DEC STD 102-3, subhead 4.2—1 sample

Weight 28 kg (61 lbs) to 38 kg (85 lbs) Skidded

a. Vibration–Repetitive Shock according to subhead 3.4.2—3 samples

b. Shock Drop[1] according to subhead 2.2.2—3 samples

c. Shock-Inclined Impact—NA

d. Random Vibration according to subhead 3.3.4—1 sample

e. Compression—TBD

f. Stability according to DEC STD 102-3, subhead 4.2—1 sample

Weight 38 kg (85 lbs) to 45 kg (100 lbs)

a. Vibration–Repetitive Shock according to subhead 3.4.2—3 samples

b. Shock Drop—NA

c. Shock-Inclined Impact[1] according to subhead 2.3.3.1—3 samples

[1] Vibration–Repetitive Shock Tests must be performed prior to these shock tests.

d. Random Vibration according to subhead 3.3.4—1 sample
e. Compression—TBD
f. Stability according to DEC STD 102-3, subhead 3.6—1 sample

Weight 45 kg (100 lbs) to 113 kg (250 lbs) Skidded or Packaged

a. Vibration–Repetitive Shock according to subhead 3.4.3—3 samples
b. Shock Drop - NA
c. Shock-Inclined Impact[1] according to subhead 2.3.2.1—3 samples
d. Random Vibration according to subhead 3.3.4—1 sample
e. Compression—TBD
f. Stability according to DEC STD 102-3, subhead 3.5 or 3.6—1 sample

Weight Greater Than 113 kg (250 lbs) Skidded or Packaged

a. Vibration–Repetitive Shock according to subhead 3.4.3—1 sample
b. Shock Drop—NA
c. Shock-Inclined Impact[1] according to subhead 2.3.2.2—1 sample
d. Random Vibration according to subhead 3.3.4—1 sample
e. Compression—TBD
f. Stability according to DEC STD 102-3, subhead 3.5 or 3.6—1 sample

1.3.3 Individual Freestanding Products or Cabinets (Unskidded and Shipped on Integral Casters)

Weight Less Than 45 kg (100 lbs)

a. Vibration–Repetitive Shock according to subhead 3.4.2—3 samples
b. Shock Drop—NA
c. Shock-Inclined Impact[1] according to subhead 2.3.3.2—3 samples
d. Random Vibration according to subhead 3.3.3—1 sample
e. Compression—TBD
f. Stability according to DEC STD 102-3, subhead 3.5—1 sample

Weight 45 kg (100 lbs) to 113 kg (250 lbs)

a. Vibration–Repetitive Shock according to subhead 3.4.3—3 samples
b. Shock Drop—NA
c. Shock-Inclined Impact[1] according to subhead 2.3.2.1—3 samples
d. Random Vibration according to subhead 3.3.3—1 sample
e. Compression—TBD
f. Stability according to DEC STD 102-3, subhead 3.6—1 sample

[1] Vibration–Repetitive Shock Tests must be performed prior to these shock tests.

Weight Greater Than 113 kg (250 lbs)

a. Vibration–Repetitive Shock according to subhead 3.4.3–1 sample

b. Shock Drop—NA

c. Shock-Inclined Impact[1] according to subhead 2.3.2.2—1 sample

d. Random Vibration according to subhead 3.3.3—1 sample

e. Compression—TBD

f. Stability according to DEC STD 102-3, subhead 3.6—1 sample

1.3.4 Consolidated Containers, Interplant Packages, Skid Loads of Multiple Packages

For consolidated containers, interplant packages, and skid loads of multiple packages:

a. No additional tests will be required for any approved customer shipping package or container that is consolidated or skidded with other items.

b. Interplant package tests are not a requirement of this standard although future interplant package testing requirements may refer to the tests and methods of this standard.

c. Replacement or alternative packaging having the same protective features as the original packaging, as determined by the responsible Package Engineer, will not require additional formal qualification tests. Local verification tests are expected to be performed to demonstrate that the alternate package does, in fact, provide equivalent protection. The replacement or alternative package is usually a low-volume package containing fabricated cushions rather than volume produced molded cushions. This type of package is commonly used for Digital Services' repairs, field replacement, distribution replacement, and end-of-life applications.

2 MECHANICAL SHOCK

Computer equipment of all classes may be exposed to mechanical shocks during operation. These occurrences are infrequent for most applications and customer sites. Mechanical shock inputs can result from a variety of sources such as neighboring machines, equipment, traffic, door slamming, and so forth. They are usually transmitted to the computer equipment through the site floor or mishandling by users. 1 G peak = acceleration of $9.8 m/s^2$ peak.

2.1 OPERATING SHOCK TEST

Operating Shock tests are specified according to product class and weight. Class A and class B environments apply to floor or desk-mounted products used in computer rooms, data centers, general offices, and light manufacturing areas.

The class C environment applies to floor, wall, or desk-mounted products used in general industrial locations, including garages, warehouses, and heavy manufacturing sites. Class C product tests do not necessarily account for applications in which the product is mounted directly on, or fastened to, other industrial equipment.

The class D operating shock environment applies to all subassemblies that are expected to mount within a system meeting class A or class B levels, without the need for additional system shock isolation features. Examples are modules, power supplies, backplanes, air movers, disk and tape drives, and so forth. Subassemblies not meeting the class D requirements may require additional shock isolation to meet system level requirements. Subassemblies meeting this requirement, but intended to mount in class C systems, may also require additional isolation.

2.1.1 Operating Mechanical Shock Test Procedures

General test procedures described in subhead 3.5 apply to these tests. The following items are specific to the Operating Mechanical Shock tests; they are intended to complement the general test procedures of subhead 3.5. In cases of overlap and/or conflict, the requirements of this subhead apply.

Analytical verification of compliance with the Operating Vibration test and the Operating Shock test is allowed in certain cases.

Use specific analytical and experimental data about the product structure to verify that levels of acceptable subassembly performance, such as obtained in subassembly operational fragility tests, are not exceeded in any subassembly location in the proposed product.

The standard owner, through the Environmental Engineering Group, must authorize any substitution of analytical verification in place of DEC STD 102-2 tests.

In all cases, the acceptance of analytical verification as a substitute for formal DEC STD 102-2 Operating Vibration and Operating Shock testing will be dependent on the formal submittal of the documented analysis, including all necessary additional technical data.

Test items

The specified Operating Shock tests are required for all hardware products. However, large, heavy products are known to be less susceptible to these exposures. In addition, fixturing large cabinets and cabinet arrays is costly and complex. Therefore, alternate test methods or the elimination of the Operating Shock test may be warranted in certain situations, for example when the minimum operable product configuration is too large to be attached to a 3 ft. $\times$ 4 ft. fixture surface. Operation of multiple cabinet systems for environmental tests is often possible by using special interconnecting cables that allow environmental exposure to each individual cabinet. The configurations are expected to be tested according to the specified tests.

The standard owner, through the Environmental Engineering Group, must authorize any alternative test method or the elimination of these specified Operating Shock tests.

Products offering multiples of identical major options in a cabinet (for example, a 1-, 2-, or 3-disk drive configuration) must verify and document operating shock according to this standard for at least the minimum and maximum configurations (in this example, the 1-disk and 3-disk drive configuration). Some of these configurations may fall under two different weight ranges and therefore require two different operating shock test levels.

Products that may be supplied in both tabletop and rack-mountable configurations are required to demonstrate capabilities in both configurations.

Supplies and expendables

The Mechanical Shock test is of such a short duration that no supply replacement should be required or accepted.

Test Conditions

The Operating Mechanical Shock test pulse parameters are intended as input to the product structure. Fasten the product to a rigid table or fixture and achieve the specified acceleration parameters directly adjacent to the product mounting surface.

The shock levels specified here are applied *once* in the horizontal or vertical direction of three orthogonal axes for tabletop products and *three* times in the vertical direction only for stand-alone or cabinet-mounted products. The entire requirement, for either case, is three total pulses.

Raw data requirements

Mechanical shock pulse data of input pulse parameters are required for each shock application.

Test apparatus criteria

The shock table or fixture used to transfer the specified shock pulse to the product must be rigid to minimize variations in actual shock levels transmitted.

The shock pulse may be generated on a conventional shock test machine, on an electrodynamic or hydraulic vibration machine, on a pivot drop apparatus, or on a flat drop apparatus.

Pass/fail criteria for Operating Mechanical Shock tests

The product must successfully operate throughout and following all specified mechanical shock exposures without any product modification or adjustment, except as noted in subhead 3.5.

Specific criteria for acceptance

a. The product must operate throughout and following all specified mechanical shock exposures. All hard and soft errors must be documented and be within the error rate criteria established by the product group prior to testing.

b. There must be no evidence of any physical defects or failures during or following these tests. Refer to subhead 3.7 for physical defect descriptions and instructions regarding specific pass or fail criteria.

2.1.2 Class A and Class B Operating Shock Test Levels for Products Weighing 45 Kg (100 lbs) or Less

The product or system will operate while a half-sine shock pulse of 10 G peak (± 1 G) and 10 ms (± 3 ms) duration is applied once in either direction of three orthogonal axes for tabletop or rack-mountable/add-on products, and applied three times in the vertical direction only for freestanding products.

2.1.3 Class A and Class B Operating Shock Test Levels For Products Weighing Between 45 Kg (100 lbs) and 113 Kg (250 lbs)

The product or system will operate while a half sine shock pulse of 7.5 G peak (± 1 G) and 10 ms (± 3 ms) duration is applied once in either direction of three orthogonal axes for tabletop products or rack-mountable/add-on products , and applied three times in the vertical direction only for freestanding products.

2.1.4 Class A and Class B Operating Shock Test Levels For Products Weighing More Than 113 Kg (250 lbs)

The product or system will operate while a half sine shock pulse of 5 G peak (± 1 G) and 10 ms (± 3 ms) duration is applied once in the horizontal or vertical direction of three orthogonal axes for tabletop or rack-mountable add-on products, and applied three times in the vertical direction only for freestanding products.

2.1.5 Class C Operating Shock Test Levels for All Products, Regardless of Product Weight

The product or system will operate while a half-sine shock pulse of 10 G peak (± 1 G) and 10 ms (±3 ms) duration is applied once in either direction of three orthogonal axes for tabletop or rack-mountable add-on products, and applied three times in the vertical direction only for freestanding products.

2.1.6 Stand-Alone Products (Rack-Mounted, Enclosure-Mounted or Freestanding)

Products supplied solely as rack-mounted or freestanding (including any type of floor enclosure) may be tested in the vertical direction only.

In this case, the appropriate shock pulse will be applied three times in the vertical direction.

Products or systems that may also be supplied in tabletop configurations are required to demonstrate capabilities in both configurations.

2.1.7 Class D Operating Shock Environment for Subassemblies

The class D test levels apply to individual subassemblies fixtured and mounted directly to the test apparatus. These class D test levels are not intended for, and should not be applied to, any complete (ready for installation) package or *host* product.

NOTE

Class D requirements are not a formal requirement for DEC STD 102-2 compliance at this time. Unless the specification for the individual subassembly actually defines the Class D capabilities, there is no DEC STD 102-2 requirement for subassembly compliance to these Class D levels of performance.

Subassemblies that do meet class D Operating Shock test environment capabilities are expected to mount within a cabinet or another product meeting class A/B levels, with minimal or no additional shock isolation. Examples are modules, power supplies, backplanes, air movers, disk and tape drives, and so on.

Subassemblies that do not meet this requirement may need additional shock isolation to meet system level requirements. Subassemblies meeting this requirement, but intended to mount in class C systems, may also need additional shock isolation.

2.1.7.1 Class D Operating Shock Test Requirements

The subassembly will operate while a half-sine shock pulse of 20 G peak (± 1 G) and 10 ms (± 3 ms) duration is applied once in the horizontal or vertical direction of three orthogonal axes for tabletop or rack-mountable/add-on products.

Class D Operating Shock test levels are reduced for any individual subassembly that weights more than 45 kg (100 lbs). For individual items weighing between 45 kg (100 lbs) and 113 kg (250 lbs), the class D test requirement is 15 G peak, 10 ms. For individual items weighing more than 113 kg (250 lbs), the class D test requirement is 10 G peak, 10 ms.

2.1.8 Operating Mechanical Shock—Noncompliant Products

Products or systems not able to meet the requirements of the DEC STD 102-2 Operating Mechanical Shock test are recommended to comply with the following procedure that qualifies the product for a formal waiver process.

If the product is a tabletop or rack-mountable/add-on item, the unit should be tested at the lower levels in the failed axis to establish a passing level before proceeding to the other axes.

If the product is a stand-alone item, and three consecutive passes cannot be achieved at the DEC STD 102-2 level, use the following procedure to achieve a level where the unit will pass three consecutive times.

1. Reduce the acceleration level to 50% of the required level, while maintaining the duration constant at 10 ms. If a pass is achieved, continue to step *2*. If a pass cannot be achieved, the DEC STD 102-2 domain manager will not endorse a formal waiver. The minimum acceptable operational level for any Digital product is 50% of the required level.
2. Increase the acceleration level to 75% of the required level, while maintaining the duration constant at 10 ms. If a pass is achieved, this level is the waiver level. If a pass cannot be achieved, the 50% level in step *1* is the waiver level.

2.2 NONOPERATING SHOCK DROP TEST (PRODUCT IN CUSTOMER SHIPPING PACKAGE)

Mechanical Shock tests aid development of shipping packages and evaluate the ability of the intended shipping package and product to withstand normal handling and delivery situations. Industrial Package Engineering may require shock test parameters exceeding these requirements to accommodate specific product vulnerabilities, different or abnormal handling expectations, or special economic considerations (such as high volume products). Any additional requirements or criteria will be agreed to and formally documented by Industrial Package Engineering and the product group.
In all cases, the requirements of subheads 2.2 and 2.3 are to be the minimum acceptable criteria regarding nonoperating mechanical shock.

Nonoperating Mechanical Shock tests are expected to be performed using only the test methods described in this standard.

2.2.1 Nonoperating Mechanical Shock Drop Test Procedures

General test procedures described in subhead 3.6 apply to these tests. The following items are specific to the Nonoperating Mechanical Shock tests; they are intended to complement the general tests procedures of subhead 3.6. In cases of overlap and/or conflict, the requirements of this subhead apply.

Number of Samples Required

Digital's criteria for approval of the packaged product according to these tests is based on data from three separate packaged-product tests. In cases where simultaneous availability of three separate product test samples is not practical or not feasible, approvals are allowed according to the alternate procedures defined in subhead 2.2.2.

Special Requirements

Perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 to the packaged-product sample before performing the Nonoperating Mechanical Shock test.

Product Shock Data Requirements

Shock pulse data is required to identify the actual mechanical shock level occurring within the product as a result of this test exposure. This data will consist of shock pulse photographs, or equivalent amplitude time history presentations, obtained from an accelerometer mounted in the product on a rigid area of the product chassis. As a minimum, one shock pulse time history is required for each flat face surface of the shipping package.

Shock pulse data may be waived for packages where accelerometer mounting is impractical.

To comply with this standard, this data is required regardless of the configuration of packaged product tested (cushioned shipping packages, products with integral cushioned casters or on cushioned shipping skids, uncushioned skids or an individual product, uncushioned shipping packages).

Test Apparatus Criteria

Perform the following Nonoperating Mechanical Shock test using equipment that complies with the following requirements of ASTM D-775, *Standard Method of Drop Test for Shipping Containers*.

1. Quick release drop hook or drop table apparatus is required for this test program. The mechanism must not impart any rotational or sidewise forces to the test package. If the drop table is used, the apparatus shall provide a spring or other mechanism so that the drop leaves do not interfere with a free, unobstructed fall. Any lifting devices should not damage the test package.
2. The test apparatus shall permit accurate control of the drop heights.
3. The test apparatus shall permit the container to be positioned prior to release, so the item's correct orientation at impact is assured. Required orientation tolerance is within 2 degrees for flat face drops and within 10 degrees for edge and corner drops.

4. The test sample must impact a flat, nonyielding, rigid surface that is integral with a mass that is at least 50 times the weight of the dropping test item such as a concrete floor or a steel plate. Impact against a wood surface is not acceptable for these drop tests.
5. A calibration sample shall be used as part of a periodic verification program to assure that impact orientation tolerances are within specifications.

This sample shall be similar in size and weight to the maximum number of items to be tested and it shall have its center of gravity at its geometric center. When this unit is dropped, it must impact within the specified orientation tolerances as determined by a photograph.

2.2.2 Packaged Products Weighing 45 kg (100 lbs) or Less

This procedure applies to any Digital product, component, or subassembly in an individual customer shipping container whose packaged product weight is equal to or less than 45 kg (100 lbs).

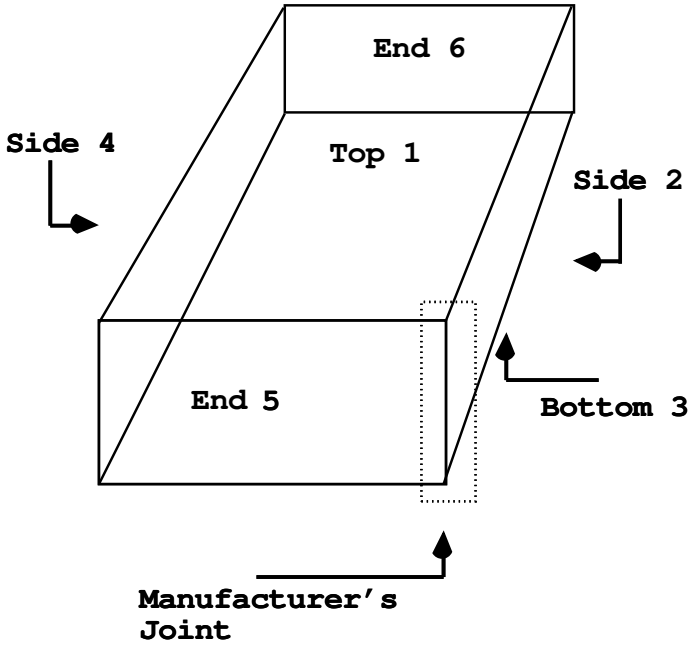
All products packaged individually in this weight range that incorporate integral skids, or in which the shipping specification or the packaging instruction requires the use of a skid or pallet for shipment, will be tested with Inclined Impact tests according to subhead 2.3.3. An integral skid is a skid or pallet that is a structural member of the shipping package or carton and, if removed, would yield an open container or exposed product. The weight of integral skid items includes the integral skid weight.

This test procedure requires that the drops be applied to the package faces in a specified sequence.

1. With the packaged product in its normal (top up) shipping position, face one end of the container towards you, ensuring that the manufacturer's joint emanates from the lower right-front corner. If this is not possible, the orientation should be adjusted so the manufacturer's joint emanates from the upper left-rear corner. Identify the surfaces as follows:

surface 1—top	surface 2—right side	surface 3—bottom
surface 4—left side	surface 5—near end	surface 6—far end

Figure 1: Manufacturer's Joint



2. Identify the edges by the numbers of the two surfaces forming the edge. Identify corners by the numbers of the three surfaces that meet to form the corner. It is expected and desired that the manufacturer's joint will emanate from the lower right-front corner. For box styles without manufacturer's joints, numbering may be from any corner as long as the package is oriented in its normal (top-up) position. Refer to Figure 1.

   Table 1 specifies test drop heights and packaged product weight.

3. Use the packaged product weight to determine the average drop height and packaged product weight of the actual test items, rounded to the nearest 45 kg (100 lb).

   The weight of the packaged product includes:

   - The product
   - Any accessories, documentation, or parts to be shipped within the carton
   - The carton or package
   - All internal indexing or cushioning materials
   - Any closure materials

4. Do not include the weight of any nonintegral shipping skid or shipping pallet in the weight of a packaged product, even if the intent is to strap the package to a shipping skid for delivery. In packages that incorporate an integral shipping skid, include the weight of the integral skid.

Table 1: Free-Fall Flat Drop Tests—Customer Shipping Packages

Total Package Weight		Drop Height	
kg	lb	cm	in
9.5 or less	20.9 lb or less	77	30
9.6 to 18.5	21 to 40.9	61	24
18.6 to 27.6	41 to 60.9	46	18
27.7 to 45	61 to 100	31	12

For approval, Digital requires criteria data from three separate packaged product tests.

a. Three product samples available simultaneously:

   Perform one application of the stated 10-drop test sequence (defined in c.) for each sample. For each test sample, use a new shipping package and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 on each packaged sample. In cases where simultaneous availability of three separate product test samples is not feasible, approvals are allowed according to the following test procedure.

b. Two product samples available simultaneously:

   1. Perform one application of the stated 10-drop test sequence (defined in c.) for each sample.
   2. Perform one additional application of the drop test sequence to one of the samples.
   3. Use either of the samples for the second application if both original tests were error- and defect-free.
   4. Subject the remaining sample to the second test application if one of the original tests produced an error or defect in a sample.
   5. Use a new shipping package for each individual drop test sequence and precede each sequence with the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4.

c. One product sample available:

   Perform three applications of the stated 10-drop test sequence to the sample.

   For each individual drop test sequence, use a new shipping package and precede each sequence with the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4. Repairs to the single-test sample may be performed by any means.

   For each drop test sequence, drop the packaged product from the required height in the following sequence:

   1. The 2-3-5 corner
   2. The shortest edge radiating from that corner
   3. The next longest edge radiating from that corner
   4. The longest edge radiating from that corner
   5. Flat on one of the smallest faces
   6. Flat on the opposite small face

7. Flat on one of the medium faces
8. Flat on the opposite medium face
9. Flat on one of the largest faces
10. Flat on the opposite largest face

2.2.3 Pass/Fail Criteria for Nonoperating Shock Tests of Products Weighing 45 kg (100 lbs) or Less

Following test exposure, remove the packaging materials and examine the product. Note any physical degradation or defects. Perform and document operational tests that verify the product operates within specifications, and it meets the documented operational criteria supplied by the product group.

The specific criteria for acceptance are:

a. Successful product operation following the specified Nonoperating Shock test exposures.

b. No evidence of any physical defects or failures, except as follows.

For approval, Digital requires data from three separate packaged-product tests. Relative to the Drop test sequence specified in subhead 2.2.2, the following failure criteria apply:

a. Where three product samples were available simultaneously:

   The test requirement described in subhead 2.2.2 was one application of the stated drop test sequence for each sample. Each sample and each drop test sequence must use a new shipping package.

   Acceptance criteria is one sample error- and defect-free (S1) and two samples (S2 and S3) with up to three minor errors or defects between them as long as the minor defects are different. Refer to subhead 3.7 for specific defect descriptions.

   Alternate acceptance procedure upon failure: As long as at least one sample is error- and defect-free, the following procedure may be performed to achieve approval following an initial failure.

   1. Attempt an additional application of the stated drop test sequence on either of the two samples that experienced failure (S2 or S3). Repairs to this sample may be performed by any means.

      Use a new shipping package for this test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test. If the results of any three of the four total tests meet the three-sample criteria, the packaged product is acceptable and passes the requirements.

   2. If attempt *1* is unsuccessful, revert to the two sample process by testing the error- and defect-free sample (S1) and passing the entire two-sample criteria that follows.

      - Use a new shipping package for this test and perform an additional Nonoperating Vibration (Repetitive Shock) test described in subhead 3.4 prior to this test.
      - Revise and completely retest the product and package following failure of this process.

b. Where two product samples were available simultaneously:

The test requirement described in subhead 2.2.2 allows one application of the stated drop test sequence for each sample. Each sample and each individual drop test sequence must use a new shipping package.

Perform one additional application of the drop test sequence to one of the samples using a new shipping package. Perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

The sample will be one that was error-free after the first exposure.

Acceptance criteria is one sample both error- and defect-free (S1) and another sample (S2) with up to three minor errors or defects as long as the defects are different.

The second application of the drop test sequence to the error- and defect-free sample (S1) results in a total of three or less minor errors or defects for the entire test program as long as defects are different from results in the other sample.

Alternate acceptance procedure upon failure: As long as one sample (S1) was error-free as required above, the following procedure may be performed to achieve approval following a failure:

1. Attempt an additional application of the drop test sequence on the second sample (S2). Repairs to this sample may be performed by any means.

   A new shipping package will be used for this test and an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 will be performed prior to this test.

   If the results of any three of these four total tests meet the two-sample criteria then the packaged product is acceptable and passes these requirements.

2. If attempt *1* is unsuccessful, revert to the one-sample process by testing the original error- and defect-free sample (S1) and passing the entire one-sample criteria.

   Use a new shipping package for this test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

   Failure of this process requires revision to the product and/or package and a complete retest.

c. Where one product sample was available:

The test requirement described in subhead 2.2.2 allows three applications of the stated drop-test sequence applied to the sample with each test sequence using a new shipping package. Use a new shipping package for each test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to each drop test sequence.

Acceptance criteria is first exposure error- and defect-free, *and* second and third applications of the drop test sequence may exhibit up to a total of three minor errors or defects for the entire test program so long as the defects are different. Repairs to the sample may be made by any means. One major error or defect is permitted in the second or third exposure.

Alternate Acceptance Procedure Upon Failure: As long as the first application was error free as required above, a fourth test exposure may be performed to attempt to achieve approval of these requirements following a failure. Repair of the sample may be made by any means.

Use a new shipping package for this test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

If the results of any three of these four total tests meet the acceptance criteria for one sample defined above, then the packaged product is acceptable and passes these requirements.

Failure of this process requires revision to the product and/or package and a complete retest.

If the number of test samples is increased, the entire test requirement must be performed for the new number of samples.

When parts fail, such as motors, brackets, and heads, retests will be performed on the entire product.

Any hard or soft operational errors during post-test operational verification in excess of the failure criteria defined by the product group constitute failure.

Except as defined in the specific test procedure for a single-test sample, the product must emerge from these mechanical shock exposures without displaying any major physical failures or defects. Refer to subhead 3.7 for specific defect descriptions.

In all cases, document in the test report the description of the observed defect, its major or minor classification, and the resulting pass or fail judgment.

2.2.4 Packaged Products Weighing More Than 45 kg (100 lbs)

The Nonoperating Drop tests are not used for Digital product and individual shipping containers in which the packaged product weight is greater than 45 kg (100 lbs).

Refer to the Inclined Impact tests described in subhead 2.3 for testing of Digital products weighing more than 45 kg (100 lbs). Three test samples are required for any individual item weighing between 45 kg (100 lbs) and 113 kg (250 lbs).

2.2.5 Nonoperating Mechanical Shock Tests of Unpackaged Products

Mechanical shock tests of unpackaged products are not required in order to assess shipping and handling capabilities. The effects of a cushioned shipping package, of integral cushioned casters, and of cushioned shipping skids on the product can be appreciably different from the effects indicated in an unpackaged shock test using a rigid fixture.

However, products that are shipped in cushioned shipping packages should be designed to withstand half-sine shock pulses of at least 40 G peak and 30 ms duration in any orthogonal product axis. Products that are designed to withstand higher peak g-levels allow more economical shipping package designs and lower costs to Digital.

Cabinet or enclosure mounted products, in which shipments using integral cushioned casters or cushioned shipping skids are expected, should be designed to withstand half sine shock pulses of 20 G peak and 30 ms duration in the vertical direction.

These shock parameters provide a basic guide for product designers; they are not intended as test parameters for acceptance to this standard.

Equipment racks incorporating cushioned caster assemblies will be tested according to the procedures of this standard without skids unless product specification and shipping and packaging instructions mandate shipping the item on a shipping skid.

2.2.6 Nonoperating Mechanical Shock Tests of Rack-Mounted or Individually Packaged Add-On Products

Perform both shock tests on products supplied in either configuration.

2.2.7 Nonoperating Mechanical Shock Tests of Skidded Items

Nonoperating Mechanical Shock tests of skidded items vary depending on the type of skid, the type of skidded item, and the weight of the skidded item.

Except for integral skids, the stated weight is the weight of the skidded item. An integral skid is a skid or pallet that is a structural member of the shipping package or carton and, if removed, would yield an open container or exposed product. Any skidded cabinet is considered an integral skid item. The weight of integral skid items includes the integral skid weight.

Skidded items will be tested as follows.

- Any skidded item weighing more than 45 kg (100 lbs) will be tested using Inclined Impact tests described in subhead 2.3.2.1 or 2.3.2.2.
- Individual packages weighing more than 45 kg (100 lbs) will be tested according to subhead 2.3.2.1 or 2.3.2.2 whether or not a shipping skid is used. These subheads also apply to skidded configurations of more than one package or product. However, previously approved individual customer shipping packages do not require additional skidded testing of skid loads or additional skidded testing of consolidation container loads.
- Any integral skid item weighing between 28 kg (61 lbs) and 45 kg (100 lbs) will be tested using Inclined Impact tests described in subhead 2.3.3.2.
- Any skidded item weighing less than 38 kg (85 lbs) will be tested without the skid using Drop Tests described in subhead 2.2.2.
- Any skidded item weighing between 38 kg (85 lbs) and 45 kg (100 lbs) will be tested using Inclined Impact tests described in subhead 2.3.3.1.

2.2.8 Nonoperating Mechanical Shock Tests for Subassemblies or Modules

The test requirements of this standard apply to individual customer shipping cartons for subassemblies and modules.

In cases where the tests are used to evaluate individual shipping packages for subassemblies, modules, or other component items, some of the specific requirements in this document, such as pulse data requirements, may not apply.

Consult the Industrial Package Engineering (IPE) group to determine the specific requirements in such situations.

2.3 NONOPERATING SHOCK TEST—INCLINED IMPACT

Inclined Impact tests are used on loaded shipping containers to determine the ability of the container to withstand impact stresses and to determine the ability of the container or interior packing to provide protection to the contents when subjected to impact stresses.

Inclined Impact tests simulate shocks that might be encountered in handling and transportation.

Inclined Impact tests described in this document are required for individually packaged products weighing more than 45 kg (100 lbs), except as noted in subhead 2.3.3.

2.3.1 Inclined Impact Test Procedures

The items specified in this subhead are specific to the Nonoperating Inclined Impact tests; they are intended to complement the general tests procedures described in subhead 3.6. In cases of overlap and conflict, the requirements of this subhead apply.

Number of samples required:

For approval, Digital requires data from three separate packaged product tests. In cases where simultaneous availability of three separate product test samples is not practical or feasible, approvals are allowed according to the procedures defined in the appropriate subheads.

Successful product operation must be demonstrated before and after performing the Inclined Impact test.

Product Data Requirements

Data about shocks within the product are not required in this test, however, this data may be considered an option to verify the actual shock levels imposed are as expected.

Test Conditions

Perform the Nonoperating Inclined Impact test using equipment that conforms to the requirements of ASTM D-880, *Standard Method of Incline Impact Test for Shipping Containers*.

Raw Data Requirements

Record the impact velocity of the dolly for each impact and the instrument used to measure the velocity of the dolly during the last 5 cm (2 in) of travel prior to impact. The accuracy shall be equal to or better than 0.03 m/s (0.1 ft/s). This measurement implies a system accuracy of 0.2 ms for a timer with a 2.5 cm (1 in) light interrupt.

All product printouts or other product output media and all notebook entries of chronological test events must be retained as part of the test data.

A photograph of a captured terminal screen is an acceptable way to retain the data.

Test Apparatus Criteria

Perform the Nonoperating Inclined Impact test using equipment that conforms to ASTM D-880. The following equipment features defined in ASTM D-880 will comply with these requirements.

a. Principal apparatus consisting of a two-rail steel track inclined 10 degrees from the horizontal, a rolling carriage or dolly, and a rigid backstop.

b. The backstop shall be a hardwood barrier of sufficient size to permit full contact with the shipping container.

c. The backstop barrier shall be constructed at the bottom of the incline with the plane of the face perpendicular to the direction of movement of the dolly.

d. The track shall accommodate the flatbed rolling carriage or dolly that is equipped with steel wheels greater than 76 mm (3 in) in diameter.

e. The flatbed rolling carriage or dolly will have a renewable face made of hardwood that is maintained free of prominent projections, such as bolt or nail heads, scores, or abrasions and splits that may affect the test results.

f. The track shall be clean, the wheels well lubricated, and the incline graduated in suitable increments.

2.3.2 Inclined Impact Test for Packaged Products Weighing More Than 45 kg (100 lbs)

Depending on the specific configuration involved, Digital's criteria for approval of packaged products weighing more than 45 kg (100 lbs) will require testing of up to three samples. For cases requiring three test samples, but where simultaneous availability of three separate product test samples is not feasible, approvals are also allowed according to the following procedures.

a. Three product samples available simultaneously:

   Apply one application of the stated Inclined Impact test sequence (six impacts) to each packaged sample.

   Use a new shipping package or skid for each test sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

b. Two product samples available simultaneously:

   Apply one application of the stated Inclined Impact test sequence (six impacts) to each packaged sample.

   Use an additional application of the Inclined Impact test sequence to one of the samples. If both original tests were error- and defect-free, either of the samples may be used for the second application. If one of the original tests produced an error or defect in a sample, the remaining sample must be subjected to the second test application.

   Use a new shipping package or skid for each test sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

c. One product sample available:

   Apply three applications of the stated Inclined Impact test sequence (six impacts) to the packaged sample.

Use a new shipping package or skid for each test sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

2.3.2.1 Individual Packaged Products or Skidded Items Weighing Between 45 kg (100 lbs) and 113 kg (250 lbs)

Perform the test described in subhead 2.3.2.3 to individually packaged products or skidded items weighing between 45 kg (100 lbs) and 113 kg (250 lbs).

Three test samples are required for these items. Use a new shipping package or skid for each test sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

Except for integral skids, the stated weight is the weight of the skidded item; it does not include the weight of the skid. Note that any cabinet that is directly affixed (bolted or clamped) to a skid is considered an integral skid item. The weight of integral skid items includes the integral skid weight.

2.3.2.2 Individually-Packaged Products or Skidded Items Weighing More Than 113 kg (250 lbs)

Except for integral skids, the stated weight is the weight of the skidded item; it does not include the weight of the skid. An integral skid is a skid or pallet that is a structural member of the shipping package or carton and, if removed, would yield an open container or exposed product. Note that any cabinet that is directly bolted or clamped to a skid is considered an integral skid item. The weight of integral skid items includes the integral skid weight.

Only one test sample is required for these items and it will be subjected to the Inclined Impact test program described in subhead 2.3.2.3. Use a new shipping package or skid for each sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

2.3.2.3 Inclined Impact Test

Follow these steps to perform the Inclined Impact test.

1. Release the empty dolly from a height on the ramp necessary to achieve a minimum impact velocity of 1.0 m/s (3.3 ft/s).
2. Center the packaged product or skid on the dolly with the panel, surface, or edge that is to receive the initial impact flush against the backstop and parallel to the leading edge of the dolly.
3. Return the dolly to the preset height in step 1 and release the dolly.
4. Record the impact velocity measured during each impact.
5. Complete the test by subjecting the remaining side panels, bottom, and top to impacts that achieve the required minimum final velocity.

   This process results in a total of six impacts. Record each final velocity measurement. If any impact is less than the required velocity of 1.0 m/s (3.3 ft/s), it must be repeated to achieve the required value.

If it is impractical to position the packaged product to effect the top and bottom impacts, the test specimen may be tested in the following manner.

a. A top impact will be eliminated for packaged products having a definite skid bottom on which the unit is to be shipped, or when the gross weight exceeds 227 kg (500 lbs).

b. In all instances, the four vertical surfaces of the packaged product must be subjected to the impacts specified in steps 1 through 5 and the bottom surface must be subjected either to the specified impact or to two tilt drops from a height of 20.3 cm (8 in). Each bottom tilt drop may be performed by raising one end (line perpendicular to the skid bottoms' longest dimension) to the required height and releasing it so that the end falls freely onto a flat, firm, nonyielding surface, such as steel or concrete.

NOTE

The tilt drop alternative must be used when it is impractical to position the packaged product for a bottom impact on the Inclined Impact tester. All skidded items will use the tilt drop alternative to accomplish the required impacts to the bottom surface.

6. Inspect both the package and the product. The packaged product shall be considered to have passed this test if, upon examination, the product is free from damage and the container still affords reasonable protection to the contents. An operational or diagnostic test must indicate satisfactory product performance following the test exposure.

2.3.3 Inclined Impact Test Procedures for Certain Packaged Products Weighing Less Than 45 kg (100 lbs)

Except for integral skids, the stated weight is the weight of the skidded item; it does not include the weight of the skid. Note that any cabinet that is directly bolted or clamped to a skid is considered an integral skid item. The weight of integral skid items includes the integral skid weight.

Digital's criteria for approval of the packaged product in accordance with these tests are based on data from three separate packaged product tests. In cases where simultaneous availability of three separate product test samples is not feasible, approvals are allowed according to the following procedures.

a. Three product samples available simultaneously:

Apply one application of the stated Inclined Impact test sequence (10 impacts) to each packaged sample.

Use a new shipping package or skid for each test sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

b. Two product samples available simultaneously:

Apply one application of the stated Inclined Impact test sequence (10 impacts) to each packaged sample.

Use one additional application of the Inclined Impact test sequence to one of the samples. If both original tests were error and defect free, either of the samples may be used for the second application. If one of the original tests produced an error or defect in a sample the remaining sample must be subjected to the second test application.

Use a new shipping package or skid for each test sample and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

c. One product sample available:

Apply three applications of the stated Inclined Impact test sequence (10 impacts) to the packaged sample.

For each application of the Inclined Impact test, use a new shipping package or skid and perform the Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

2.3.3.1 Skidded Items Weighing Between 38 kg (85 lbs) and 45 kg (100 lbs)

Any product or package weighing between 38 kg (85 lbs) and 45 kg (100 lbs) in which the packaging specification or packaging instruction requires the use of a shipping skid for delivery will be tested using the Inclined Impact test described in subhead 2.3.3.3. These packaged items will be tested as individual packages without shipping skids.

Any skidded item weighing less than 38 kg (85 lbs) will be tested using Drop tests described in subhead 2.2.2. Note that any skidded cabinet that is directly fixed (bolted) to a skid is considered an integral skid item.

2.3.3.2 Items That Incorporate an Integral Skid and Weigh Between 28 kg (61 lbs) and 45 kg (100 lbs)

Any product or package that incorporates an integral shipping skid and weighs between 28 kg (61 lbs) and 45 kg (100 lbs) will be tested using the Inclined Impact test described in subhead 2.3.3.3. Note that any skidded cabinet that is directly bolted to a skid is considered an integral skid item.

2.3.3.3 Inclined Impact Test

Follow these steps to perform the Inclined Impact test.

1. Release the empty dolly from a height up the ramp necessary to achieve a minimum impact velocity of 1.0 m/s (3.3 ft/s).
2. Center the packaged product or skid on the dolly with the panel, surface, or edge that is to receive the initial impact flush against the backstop and parallel to the leading edge of the dolly.
3. Release the dolly from the height determined in step 1.
4. Record the impact velocity measured during each impact.
5. Impact the packaged product as specified above in the following sequence:
   a. The 2-3-5 corner
   b. The shortest edge radiating from that corner
   c. The next longest edge radiating from that corner
   d. The longest edge radiating from that corner
   e. Flat on one of the smallest faces
   f. Flat on the opposite small face
   g. Flat on one of the medium faces

h. Flat on the opposite medium face

i. Flat on one of the largest faces

j. Flat on the opposite large face

This process will result in a total of ten impacts. Record each final velocity measurement. If any impact is less than the required velocity of 1.0 m/s (3.3 ft/s), it must be repeated to achieve the required value.

6. Inspect both the package and the product. The packaged product shall be considered to have passed this test if, upon examination, the product is free from damage and the container still affords reasonable protection to the contents. It is required that an operational or diagnostic test indicate satisfactory product performance following the test exposure.

2.3.4 Pass/Fail Criteria for Inclined Impact Tests

The major and minor defect descriptions in subhead 3.7 apply to the criteria for Inclined Impact tests described in subheads 2.3.2.3 and 2.3.3.3.

In all cases, document in the test report the description of the observed defect, its major or minor classification, and the resulting pass or fail judgment.

2.3.4.1 Pass/Fail Criteria for Inclined Impact Tests of Products or Skidded Items Weighing Between 45 kg (100 lbs) and 113 kg (250 lbs) and for Certain Items Weighing Less Than 45 kg (100 lbs)

The following criteria applies to any Inclined Impact tests performed on items defined in subheads 2.3.2.1, 2.3.3.1, and 2.3.3.2.

Where three product samples were available simultaneously:

Three-sample criteria

The test requirements described in subhead 2.3.2 and 2.3.3 require one application of the stated test sequence for each sample. Each test sequence must use a new shipping package.

Acceptance criteria is one sample error- and defect-free (S1) and two samples (S2 and S3) with up to three minor errors or defects between them as long as the defects are different.

Alternate acceptance procedure upon failure: As long as at least one sample is error-free, the following procedure may be performed in order to achieve approval of these requirements following an initial failure:

1. Attempt an additional application of the stated test sequence on either of the two samples that experienced failure above (S2 or S3). Repairs to this sample may be performed by any means.

   Use a new shipping package for this test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test. If the results of any three of the four total tests meet the three sample criteria, the packaged product is acceptable and passes these requirements.

2. If attempt *1* is unsuccessful, revert to the two-sample process by testing the error-free sample (S1) and passing the entire two sample criteria stated below. Use a new shipping package for this test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

   Failure of this process requires revision to the product and/or package and a complete retest.

Where two product samples were available simultaneously:

The test requirements from subhead 2.3.2 or 2.3.3 was one application of the stated test sequence for each sample with each sample and each individual test sequence using a new shipping package.

Perform one additional application of the test sequence to one of the samples using a new shipping package. Perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 on the sample prior to this test.

The sample will be one that was error-free after the first exposure.

Acceptance Criteria is:

One sample error- and defect-free (S1), *and* another sample (S2) with up to three minor errors or defects as long as the defects are different. The second application of the test sequence to the error- and defect-free sample (S1) results in a total of three or less minor errors or defects for the entire test program as long as the defects are different from results in the other sample.

Alternate acceptance procedure upon failure:

As long as one sample (S1) was error-free as required above, the following procedure may be performed to attempt to achieve approval of these requirements following a failure:

a. Attempt an additional application of the test sequence on the second sample (S2). Repairs to this sample may be performed by any means.

   A new shipping package will be used for this test and an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 will be performed prior to this test.

   If the results of any three of these four total tests meet the two-sample criteria then the packaged product is acceptable and passes these requirements.

b. If attempt *a* is unsuccessful, revert to the one-sample process by testing the original error-free sample (S1) and passing the entire one-sample criteria following.

   A new shipping package will be used for this test and an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 will be performed prior to this test.

   Failure of this process requires revision to the product and/or package and a complete retest.

Where one product sample was available:

The test requirement from subheads 2.3.2 or 2.3.3 was three applications of the stated test sequence applied to the sample with each test sequence using a new shipping package. Use a new shipping package for each test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to each test sequence.

Acceptance criteria is first exposure error- and defect-free, *and* two samples (S2 and S3) with up to three minor errors or defects between them as long as the defects are different. Repairs to the sample may be made by any means. One major error or defect is permitted in the last exposure.

Alternate acceptance procedure upon failure: As long as the first application was error-free as required previously, a fourth test exposure may be performed to achieve approval of these requirements following a failure. Repair of the sample may be made by any means.

Use a new shipping package for this test and perform an additional Nonoperating Vibration–Repetitive Shock test described in subhead 3.4 prior to this test.

If the results of any three of these four total tests meet the acceptance criteria for one sample defined above, then the packaged product is acceptable and passes these requirements.

Failure of this process requires revision to the product and/or package and a complete retest.

Should additional samples become available during or following any of the described tests, the entire test sequence for the new number of samples must be performed. The same samples may be used for any number of test passes but prior results may not be used except as specifically defined previously.

2.3.4.2 Pass/Fail Criteria for Inclined Impact Tests of Products or Skidded Items Weighing Greater Than 113 kg (250 lbs)

The acceptance criteria for these items is successful product operation and no evidence of any physical defects or failures in the product following the test sequence. Refer to subhead 3.7 for descriptions.

2.4 OVERSTRESS SHOCK (BENCH-HANDLING) TEST—NONOPERATING AND UNPACKAGED

Bench-handling tests are used on smaller tabletop items to determine the ability of the unpackaged product to withstand shock stresses in the nonoperating condition.

Bench-handling tests are useful in simulating shocks that might be encountered in the transportation from one workspace to the next, or during service of a tabletop unit in the nonoperating condition.

These Bench-handling tests are required for all tabletop products or other products that might be subject to rough handling in the nonoperating mode.

NOTE

Successful, error-free operating during this overstress test is not necessary for acceptable product conformance to this standard.

This procedure is taken from MIL STD 810, *Environmental Test Methods and Engineering Guidelines*, Method 516.3.

2.4.1 Overstress Shock (Bench-Handling) Test Procedures

The following specified items are specific to the Overstress Shock tests and they are intended to complement the general tests procedures described in subhead 3.6. In cases of overlap and conflict, the requirements of this subhead apply.

Shipping Packages and Shipping Materials

These materials are not required nor authorized during Overstress Shock (Bench-Handling) test. Shipping brackets or shipping fasteners attached to the product for shipment will be removed for this test.

Product Operation

Perform this test with the nonoperating product but in its operating configuration. For products with removable disk media, remove the media prior to performing the bench-handling test.

Test Apparatus Criteria

Use the following procedure to perform the Nonoperational Unpackaged Mechanical Shock test.

1. The test sample shall impact a flat, nonyielding, rigid surface that is integral with a mass at least 50 times the weight of the dropping test item.
2. The test apparatus shall accurately control the tilt drop heights or angles.

2.4.2 Unpackaged Tabletop Products

This procedure applies to any Digital product that can be used as a desk-top item.

1. Using one edge as a pivot, lift the opposite edge of the chassis until one of the following conditions occurs (whichever occurs first).
   a. The chassis forms an angle of 45 degrees with the horizontal bench top.
   b. The lifted edge of the chassis has been raised four inches above the horizontal bench top.
   c. The lifted edge of the chassis is just below the point of perfect balance.
2. Let the chassis drop back freely to the horizontal bench top. Repeat, using other practical edges of the same horizontal face as pivot points for a total of four drops.

2.4.3 Acceptance Criteria

Following the test exposure, examine the product; explicitly note any physical degradation or defects in the final report. Perform and document operational tests that verify that the product operates within specifications, and that it meets the documented operational criteria supplied by the product group.

The specific criteria for acceptance are:

a. Successful product operation following the specified nonoperating overstress shock test exposures.

b. No evidence of any physical defects or failures. Refer to subhead 3.5 for specific descriptions.

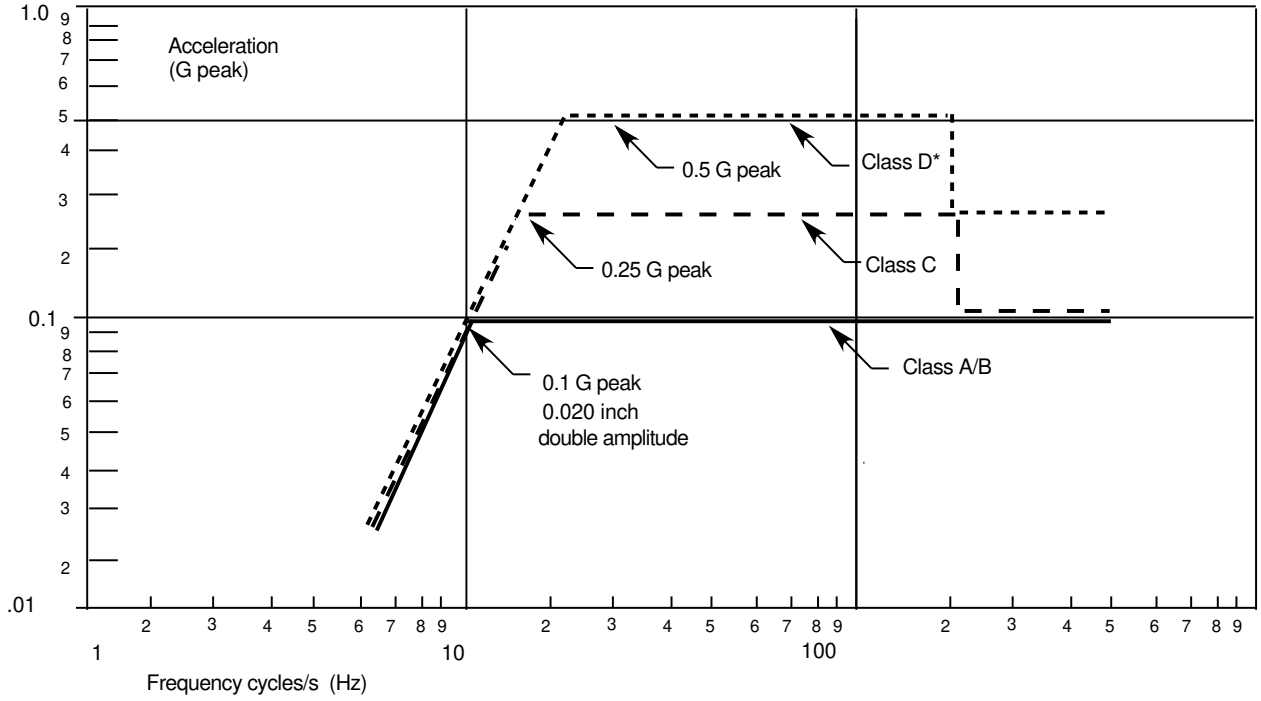
3 VIBRATION

The following subheads describe the Operating Sine-Vibration tests.

3.1 OPERATING VIBRATION TEST—SINE VIBRATION

The product must operate within specifications during the appropriate sine-vibration tests described in subheads 3.1.2, 3.1.3, and Figure 2. Apply the test once in each of three orthogonal axes.

Figure 2: Operating Vibration Test Requirements



* Not a formal DEC STD 102–2 requirement

Test freestanding products and rack-mountable products tested in cabinets while hard-mounted to the vibration table. During these tests, disable cushioning or isolation methods used for transportation and remove shipping brackets or shipping fasteners attached to the product for shipment.

Perform tests on an individual rack-mountable product using a rigid test fixture that allows the product to be mounted using its normal mounting methods.

Operating Vibration tests are specified as class A and class B environments (see subhead 3.1.2) for products used in computer rooms, data centers, general offices, and light manufacturing applications. Class C environment (see subhead 3.1.3) are specified for products used in general manufacturing and industrial applications. Class C does not

necessarily account for applications in which the product is mounted directly or fastened to other equipment.

Class D applies to individual subassemblies fixtured and mounted directly to the test apparatus.

Each of these Operating Vibration tests is derived using various data and assumptions. These test profiles represent a composite vibration exposure and test amplitudes exceed any expected individual site input.

3.1.1 Operating Vibration Test Procedures

The following items are specific to the Operating Vibration tests; they are intended to complement the general tests procedures of subhead 3.5. In cases of overlap and conflict, the requirements of this subhead apply.

Analytical verification of acceptance to DEC STD 102-2 Operating Vibration and Operating Shock may be allowed in certain cases.

Use specific analytical and experimental data about the system or product structure to verify that levels of acceptable subassembly performance, such as obtained in subassembly operational fragility tests, are not exceeded in any subassembly location in the proposed system.

The standard owner, through the Environmental Engineering Group, must authorize any substitution of analytical verification in place of physical DEC STD 102-2 tests.

In all cases, the acceptance of analytical verification as an acceptable substitute for formal DEC STD 102-2 Operating Vibration and Operating Shock testing will be dependent on the formal submittal of the documented analysis, including all necessary additional technical data.

Test Items

The specified Operating Vibration tests are required for all systems. However, large, heavy products are known to be less susceptible to site vibration inputs and, in fact, vibration effects in the largest systems are often a result of vibration generated internally by the product. In addition, fixturing large cabinets and cabinet arrays is costly and complex, as are the DEC STD 102-2 vibration tests of such large systems. Accordingly, alternate test methods, or the elimination of the Operating Vibration test, may be warranted in certain situations of large or multiple cabinets where the minimum operable test configuration is too large to be attached to a 3 ft $\times$ 4 ft fixture surface. Operation of multiple cabinet systems for environmental tests is often possible by using special interconnecting cables which allow environmental exposure to each individual cabinet and these configurations are expected to be tested according to the specified tests.

The standard owner, through the Environmental Engineering Group, must authorize any alternative method or the elimination of these specified Operating Vibration tests.

Products offering multiples of identical major options in a cabinet (for example, a 1-, 2-, or 3-disk drive configuration) must verify and document operating vibration performance according to this standard for at least the minimum and maximum configurations (in this case, the 1-disk and 3-disk configuration).

Products or systems that may be supplied in both tabletop and rack-mountable configurations are required to demonstrate capabilities in both configurations.

Test Apparatus Criteria

The vibration equipment table and fixture must be sufficiently rigid to minimize variations in actual vibration levels transmitted to the product as the required frequency range is traversed. Single-point vibration control is normally sufficient for controlling these tests.

For cases where strong fixture resonances exist, especially at frequencies below 200 Hz, multipoint averaging control should be used to minimize the potential for serious overtesting of the product. The need for multipoint averaging control can be expected for all cases of cabinet-mounted products. The control accelerometers in multipoint averaging control tests should be placed adjacent to the product-mounting surfaces, at opposite sides or corners of the product.

3.1.2 Class A/B Environments

Class A/B Operating Vibration environments apply to floor- or desk-mounted products used in computer rooms, data centers, general offices, and light manufacturing areas.

General offices include private offices with doors and full-height partitions, general open office areas, and equipment areas designated for copiers and other office equipment. Manufacturing areas include light manual assembly areas, labs, and similar work spaces. Products in these areas may experience intermittent exposures of light-to-moderate shock and vibration.

Table 2: Class A/B Vibration Test Requirements

Frequency	Acceleration
5-10 Hz	0.020 in (0.5 mm) double amplitude (DA)
10-500-10 Hz	0.1 G peak (1.0 m/s^2)
10-5 Hz	0.020 in (0.5 mm) DA
Sweep rate of 1 octave/minute	

3.1.3 Class C Environment

The class C Operating Vibration environment applies to floor-, wall- or desk-mounted products used in general industrial locations including garages, warehouses, and heavy manufacturing sites. Products may be located in the vicinity of, but not attached to, processing equipment typically used in paper mills and chemical and power plants. Products in these areas may experience intermittent exposures of moderate shock and vibration.

Table 3: Class C Vibration Test Requirements

Frequency	Acceleration
5-16 Hz	0.020 in (0.5 mm) DA
16-200 Hz	0.25 G peak (2.5 m/s^2)
200-500-200 Hz	0.1 G peak (1.0 m/s^2)
200-16 Hz	0.25 G peak (2.5 m/s^2)
16-5 Hz	0.020 in (0.5 mm) DA
Sweep rate of 1 octave/minute	

3.1.4 Class D Operating Vibration Environment for Subassemblies

These class D test levels apply to individual subassemblies fixtured and mounted directly to the test apparatus; they are not intended for any system or *host* product exposures.

NOTE

Class D requirements are not a formal requirement for DEC STD 102-2 compliance at this time. Unless the specification for the individual subassembly actually defines the Class D capabilities, there is no DEC STD 102-2 requirement for subassembly compliance to these Class D levels of performance.

Subassemblies that do meet these class D Operating Vibration environment capabilities are expected to mount within a system meeting class A/B levels with minimal or no additional vibration isolation. Examples are modules, power supplies, backplanes, air movers, disk and tape drives, and so on.

Subassemblies that do meet this requirement may need additional shock isolation to meet system level requirements. Subassemblies meeting this requirement, but intended to mount in class C systems may also require additional shock isolation.

Table 4: Class D Operating Vibration Test Requirements

Frequency	Acceleration
5-22 Hz	0.020 in (0.5 mm) DA
22-200 Hz	0.5 G peak (5.0 m/s^2)
200-500 Hz	0.25 G peak (2.5 m/s^2)
500-200 Hz	0.25 G peak (2.5 m/s^2)
200-22 Hz	0.5 G peak (5.0 m/s^2)

Table 4 (Cont.): Class D Operating Vibration Test Requirements

Frequency	Acceleration
22-5 Hz Sweep rate of 1 octave/minute	0.020 in (0.5 mm) DA

3.1.5 Pass/Fail Criteria for Operating Vibration Tests

The product must operate successfully during and following all specified operating vibration exposures without any product modification or adjustment except as allowed under subhead 3.1.1 or 3.5.

The specific criteria for acceptance are:

a. Successful product operation during and following the specified Operating Vibration test exposure.

b. No evidence of any physical defects or failures. Refer to subhead 3.7 for descriptions.

Any hard or soft operational errors during post-test operational verification in excess of the failure criteria defined by the product group constitute failure.

Figure 4 defines the media failure criteria and the resolution procedure.

In all cases, document in the test report the description of the observed defect, its major or minor classification, and the resulting pass or fail judgment.

3.1.6 Operating Vibration—Noncompliant Products

If products or systems are unable to meet the requirements of the DEC STD 102-2 Operating Vibration test, the following formal waiver procedure may be followed.

1. For a noncompliant class A/B product, determine bands of excitation frequencies over which acceptable class A/B performance is demonstrated. Segment the DEC STD 102-2 class A/B test specification into bands of frequency, then test the product over the individual bands to determine which bands meet the specification. The waivered product specification will refer to the product's ability to meet DEC STD 102-2 class A/B vibration over the specific frequency ranges demonstrated.
2. For a noncompliant class C product, or class D subassembly, the same rationale applies with the additional option of determining a lower acceleration level of compliance in the deficient frequency bands. For example, a noncompliant class C product may meet the DEC STD 102-2 class C specification except for the frequency band of 50 Hz to 100 Hz over which it meets the class A/B specification. The lower acceleration levels used for a frequency band should be the requirements of the next lower DEC STD 102-2 class.
3. In all cases, a failed tabletop or rack-mountable/add-on item should be first tested with this procedure in the failed axis to establish the passing level before proceeding to the other axes.

3.2 OPERATING VIBRATION OVERSTRESS — SINE VIBRATION

The Operational Vibration Overstress test identifies whether additional operational capabilities or margins exist in the product. It is not a requirement that products remain error free during this exposure.

3.2.1 Overstress Vibration Test Procedures

The following items are specific to the Overstress Vibration tests; they are intended to complement the general tests procedures of subhead 3.5. In cases of overlap and conflict, the requirements of this subhead apply.

Test Samples

Exposure to this Operational Vibration Overstress is only required of products that successfully pass the basic DEC STD 102-2 Operating Vibration test requirements and is primarily intended for smaller, high volume products.

The application of this Overstress test to large, expensive Digital products should be decided on a case-by-case basis. Consideration for exempting this test should be given to these products, especially when there are sufficient physical similarities between the new product and a product previously subjected to this Overstress test. Digital products that, due to their size, are exempted from the basic Operating Vibration tests are also exempted from Overstress tests.

Physical Damage

Physical damage is not expected nor desired as a result of this Operating Vibration Overstress exposure. Should a physical failure or major physical defect be experienced during the Overstress exposure, additional tasks will be required to determine whether the occurrence warrants corrective action. A retest of an additional sample may be warranted to verify repeatability of the weakness. Consult the standard owner, through the Environmental Engineering Group, for guidance in all cases.

3.2.2 Overstress Vibration Requirements

The Overstress Operating Vibration test consists of a single-sine vibration exposure of 0.1 G peak greater acceleration amplitude than the basic product class amplitude (from 5 Hz to 500 Hz to 5 Hz) applied in the vertical direction only. Perform the test by applying the basic 0.5 mm (0.020 in) DA up to the crossover frequency appropriate for the higher acceleration level. Record and document operational and diagnostic errors or faults during this exposure even though there is no requirement to achieve any acceptable level of error-free operation. Refer to Figure 2.

3.3 NONOPERATING RANDOM VIBRATION TEST (PRODUCT IN SHIPPING PACKAGE)

The product-packaging system shall be designed to protect the contents from the effects of random vibration such as that present during transportation. Random Vibration test profiles include vibration levels reported for various modes of transport and accommodate differences in Vibration test control equipments.

3.3.1 Nonoperating Random Vibration Test Procedure

The following items are specific to the Nonoperating Random Vibration tests; they are intended to complement the general tests procedures of subhead 3.6. In cases of overlap and/or conflict, the requirements of this subhead apply.

Product vibration data requirements

There are no requirements to obtain vibration data on or within the product.

Test Conditions

The Nonoperating Vibration test parameters are intended as input to the product structure such as those resulting from normal transportation and shipping exposure. For these tests, the product is to be restrained. Test skidded cabinet products with the skid base fastened to the test fixture so that cushioning remains operable.

Raw Data Requirements

Vibration control point data of input parameters is required for each test exposure. Obtain this data on the test table or on the test fixture adjacent to the product mounting points. Additional product data may be desired or advised, however, the only requirement of this standard is for control point data.

Test Apparatus Criteria

The vibration equipment table and fixture must be sufficiently rigid to minimize variations in actual vibration levels transmitted to the product as the required frequency range is traversed. Single-point vibration control is normally sufficient for controlling these tests.

However, for cases where strong fixture resonances exist, especially at frequencies below 200 Hz, use multipoint averaging control to minimize the potential for serious overtesting of the product.

The need for multipoint averaging control can be expected for all cases of cabinet-mounted products. In multipoint averaging control tests, place the control accelerometers adjacent to the product-mounting surfaces at opposite sides or corners of the product.

3.3.2 Random Vibration Test Specifications

The product-packaging system shall be designed to protect the contents from the effects of random vibration such as that present during transportation. The random vibration profiles defined include measured vibration spectra reported for various transportation modes. Use a new unused shipping package (or a new unused shipping skid, as appropriate) for these vibration tests.

a. Tests using analog (40 or 80 channel/slide wire) random controllers:

   Analog random vibration controllers are not to be used for these vibration tests.

b. Tests using digital random controllers:

   Vertical axis excitation: 1.03 G rms overall from 5 to 300 Hz. Power spectral density 0.0024 g^2/Hz at 5 Hz, increasing at 8 dB/octave to 0.015 g^2/Hz at 10 Hz. Flat 0.015 g^2/Hz from 10 to 50 Hz with 8 dB/octave roll off from 50 to 300 Hz.

NOTE

All individual nonskidded packages will use the vertical axis excitation for test inputs in each of the required three axes.

Longitudinal and lateral axis excitation: 0.698 G rms overall from 5 to 200 Hz. Power spectral density 0.0011 g^2/Hz at 5 Hz, increasing at 8 dB/octave to 0.007 g^2/Hz at 10 Hz. Flat 0.007 g^2/Hz from 10 to 50 Hz with 8 dB/octave roll off from 50 to 200 Hz. See Figure 3. (Skidded products and stand-alone products only).

Test duration shall be one hour in each axis (three hours total). The test will be performed with the products prepared as shipped, including any shipping brackets or protective materials.

3.3.3 Rack-Mounted and Stand-Alone Products or Systems

For rack-mounted and stand-alone products or systems using cushioned shipping skids, the skid base will be attached to the shaker table to allow cushioning during tests. New unused shipping skids must be provided for this test.

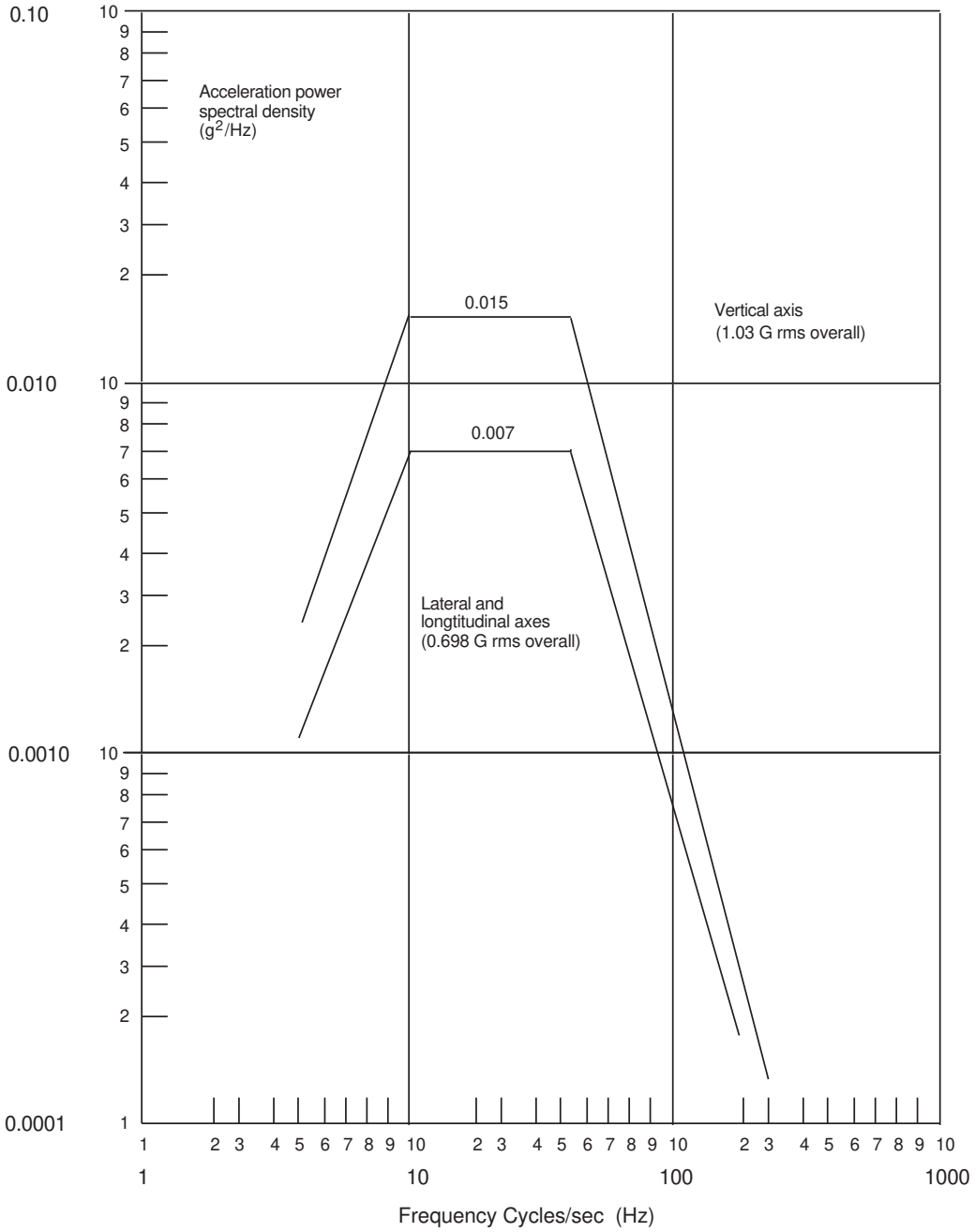
3.3.4 Product or System in Individual Customer Shipping Packages

Each product shall be provided with a shipping package designed to withstand the Random Vibration tests described in subhead 3.3.2.

For individual shipping containers, the vertical axis vibration profile will be applied to each of three adjacent faces of the shipping package for a duration of one hour each.

The packaged product will be fastened to the vibration table or fixture during these exposures.

Figure 3: Nonoperating Vibration Test Requirements for Tests Using Digital Random Vibration Controllers



3.3.5 Products Supplied Both Rack-Mounted and in Individual Product Shipping Packages

Products that may be supplied in either configuration must be tested in both configurations.

3.3.6 Pass/Fail Criteria for Nonoperating Random Vibration Tests

Following test exposure, remove the packaging materials and examine the product. Explicitly note any physical degradation or defects. Verify by means of the diagnostics or operational tasks operation of the product within specifications.

The specific criteria for acceptance are:

a. Successful product operation following the specified Nonoperating Vibration test exposure.

b. No evidence of any physical defects or failures in the product. Refer to subhead 3.7 for descriptions.

Some package or skid cushioning set may be experienced and will be acceptable as long as normal access by handling machines (fork lift, pallet truck) is not hindered.

In all cases, document in the test report the description of the observed defect, its major or minor classification and the resulting pass or fail judgment.

3.4 NONOPERATING VIBRATION—REPETITIVE SHOCK TEST (PRODUCT IN SHIPPING PACKAGE)

This Nonoperating Vibration–Repetitive Shock test is applied to each test sample prior to the exposures of subhead 2.2 (Drop Test) and subhead 2.3 (Inclined Impact Test). Each sample defined in these tests must successfully withstand the Nonoperating Vibration—Repetitive Shock exposures.

3.4.1 Nonoperating Vibration—Repetitive Shock Test Procedure

The following items are specific to the Nonoperating Vibration—Repetitive Shock tests; they are intended to complement the general test procedures of subhead 3.6. In cases of overlap and/or conflict, the requirements of this subhead apply.

Use this test to assess the adequacy of the shipping container, its internal indexing, and its closure to protect the product. These tests are not intended for quantifying product dynamic response characteristics.

Raw Data Requirements

The vibration frequency applied and the duration of the test in each axis must be documented.

Test Apparatus Criteria

Use the following vibration equipment that complies with the requirements of ASTM D-999, *Standard Method for Vibration Testing of Shipping Containers*.

The vibration equipment will produce synchronous motion or a vertical linear motion with a total excursion capability of 2.5 cm (1 in). The vibration equipment will include a tachometer or speed indicator for determining shaft r/min (or table excitation frequency in cycles per minute).

A metal shim approximately 5.1 cm (2 in) wide, 0.16 cm (1/16 in) thick, and at least 15 cm (6 in) long, and a stop watch or equivalent timer is required.

3.4.2 Test Procedure for Nonoperating Vibration—Repetitive Shock Test for Packaged Products Weighing 45 kg (100 lbs) or Less

Use the following procedure to test packaged products weighing 45 kg or less.

NOTE

Test packages that are shipped to a laboratory site for testing must be over-cartoned to ensure arrival in perfect condition.

1. Place the packaged product on the table of the vibration tester in the position the product is normally shipped. Fences may be attached to the table of the vibration equipment when required to prevent excessive rocking or movement on the table.
2. Set the vibration frequency at the minimum speed sufficient to cause the packaged product to momentarily leave the table by 0.16 cm (1/16 in) so that at least a 10 cm (4 in) length of the 0.16 cm (1/16 in) thick shim may be inserted between the bottom of the package and the surface of the table. The shim should be capable of being intermittently moved along one entire edge of the longest dimension of the package.
3. Vibrate the packaged product for a total of 14,200 vibratory impacts (the total test time in minutes to achieve this requirement is determined by dividing 14,200 by the actual frequency, in cycles per minute, set in step 2). During all tests, except those performed on vibration machines that produce pure vertical linear motion, a single 90-degree horizontal rotation should be affected after one half of the vibration impacts have been accomplished.

   If a single 90-degree horizontal rotation is impractical because of the size of the packaged product, a 180-degree horizontal rotation will be permitted.
4. Inspect the exterior of the container for any visible damage. Check for looseness of product or components.

3.4.3 Test Procedure for Nonoperating Vibration—Repetitive Shock Test for Packaged Products Weighing More Than 45 kg (100 lbs)

Use the following procedure to test packaged products weighing more than 45 kg.

NOTE

Test packages that are shipped to a laboratory site for testing must be over-cartoned to ensure arrival in perfect condition.

1. Place the packaged product on the table of the vibration tester in the position the product is normally shipped. Fences may be attached to the table of the vibration equipment when required to prevent excessive rocking or movement on the table.
2. Set the vibration frequency at the minimum speed sufficient to cause the packaged product to momentarily leave the table by a 0.16 cm (1/16 in) distance so that at least a 10 cm (4 in) length of the 0.16 cm (1/16 in) thick shim may be inserted between the bottom of the package and the surface of the table. The shim should be capable of being intermittently moved along one entire edge of the longest dimension of the package.

3. Vibrate the packaged product for a total of 11,800 vibratory impacts (the total test time in minutes to achieve this requirement is determined by dividing 11,800 by the actual frequency, in cycles per minute, set in step 2. During all tests, except those performed on vibration machines that produce pure vertical linear motion, a single 90-degree horizontal rotation should be affected after one half of the vibration impacts have been accomplished.

   If a single 90-degree horizontal rotation is impractical because of the size of the packaged product, a 180-degree horizontal rotation will be permitted.

4. Inspect the exterior of the container for any visible damage. Check for looseness of product or components.

3.4.4 Pass/Fail Criteria for Nonoperating Vibration—Repetitive Shock Tests

Following each individual Nonoperating Vibration–Repetitive Shock test exposure, the package will be opened to verify that any cushioning or indexing materials remain generally in place so that testing can continue.

Shipping packages should be opened so that any disruption to cushions or indexing material is minimized. That is, shipping cartons should simply be opened normally, and cabinet packages should be opened at the top assuming that is the easiest access.

If, at any time, it is suspected that damage to the product has occurred, a more detailed inspection may be required to verify the product condition. This level of disassembly may require a complete retest of the test sequence which was disturbed by the inspection process.

The specific criteria for acceptance are:

a. Successful product operation following each Nonoperating Vibration–Repetitive Shock test and Nonoperating Shock/Incline Impact test series.

b. No evidence of any physical defects or failures in the product. Refer to subhead 3.7 for descriptions.

Some package or skid cushioning set may be experienced and will be acceptable as long as there is no compromise to the product(s) within and normal access by handling machines (fork lift, pallet truck) is not hindered.

3.5 OPERATING TESTS—GENERAL PROCEDURES

The following subheads describe the general procedures used during operating tests.

3.5.1 Test Samples

a. Unless otherwise specified in an individual subhead, the operating tests of this standard are normally satisfied by testing one representative sample of the product.

   Analytical verification of acceptance to DEC STD 102-2 Operating Vibration and Operating Shock may be allowed in certain cases.

   Use specific analytical and experimental data about the product structure to verify that levels of acceptable subassembly performance, such as obtained in subassembly operational fragility tests, are not exceeded in any subassembly location in the proposed system.

The standard owner, through the Environmental Engineering Group, must authorize any substitution of analytical verification in place of physical DEC STD 102-2 tests.

In all cases, the acceptance of analytical verification as an acceptable substitute for formal DEC STD 102-2 Operating Vibration and Operating Shock testing will be dependent on the formal submittal of the documented analysis, including all necessary additional technical data.

b. 50 Hz or 60 Hz test sample—Either test item is acceptable for any Operating tests. It is not required to test each configuration unless physical differences exist that would warrant such testing.

c. Shipping packages and shipping materials—Not required or allowed during the Operating tests. Shipping brackets or shipping fasteners attached to the product for shipment will be removed for these tests.

d. Subassemblies or modules—To achieve formal DEC STD 102-2 approval, individual items such as subassemblies and modules must be tested and evaluated while installed in a host product. The host product chosen for these tests must represent the most demanding configuration expected of the subassembly or module. Class D requirements apply to tests of individual subassemblies or components. However, Class D is not a formal requirement for subassemblies at this time and formal DEC STD 102-2 approval of subassemblies, components, or modules must be accomplished by testing in a host product. If an item is Class D compliant, these separate tests do not need to be performed.

   Any operating test of a subassembly or module in a host product must demonstrate successful host performance for the subassembly or module to be considered acceptable. Operational problems in the host product may be encountered during these tests. If a specific operational failure or problem can be conclusively shown to be totally unrelated to and isolated from any cause or effect of the specific subassembly or module under test, the subassembly or module under test in the host product may be considered to have passed these requirements as long as the subassembly or module has experienced no physical damage and the successful operation of the subassembly or module can be demonstrated. All such occurrences will be documented in the formal test report for possible action.

NOTE

An individual subassembly or module may require environmental capabilities beyond those defined in this standard to accomplish a specific operation in a host product. Specific individual subassembly and module requirements will vary due to physical differences among host products and mounting conditions.

3.5.2 Product Operation During Tests

Tests will be performed with the product performing a diagnostic routine or an actual operational task. If the product has read and write capabilities, reads and writes must be performed during the exposure. Successful product operation requires that the product operate within specification throughout and following each test exposure.

It is intended that the definition of hard errors, soft errors, and acceptance limits on these product errors will be provided by the product group in writing prior to the start of the tests. Any hard- or soft-operational errors during post-test operational verification in excess of the failure criteria defined by the product group constitute failure.

When parts fail, such as motors, brackets, and heads, retests of the entire product will normally be required.

Retain product printouts and other output media records and include excerpts in the formal test report to document product operation.

3.5.3 Adjustments to Products Under Test

Operator adjustments to the product under test are acceptable.

Any adjustment considered a service personnel adjustment requires a repeat of the entire Operating test exposure for the particular environment.

Replacement of any component, subassembly, or assembly of the product requires a repeat of the entire Operating test exposure for the particular environment.

3.5.4 Product Data Requirements

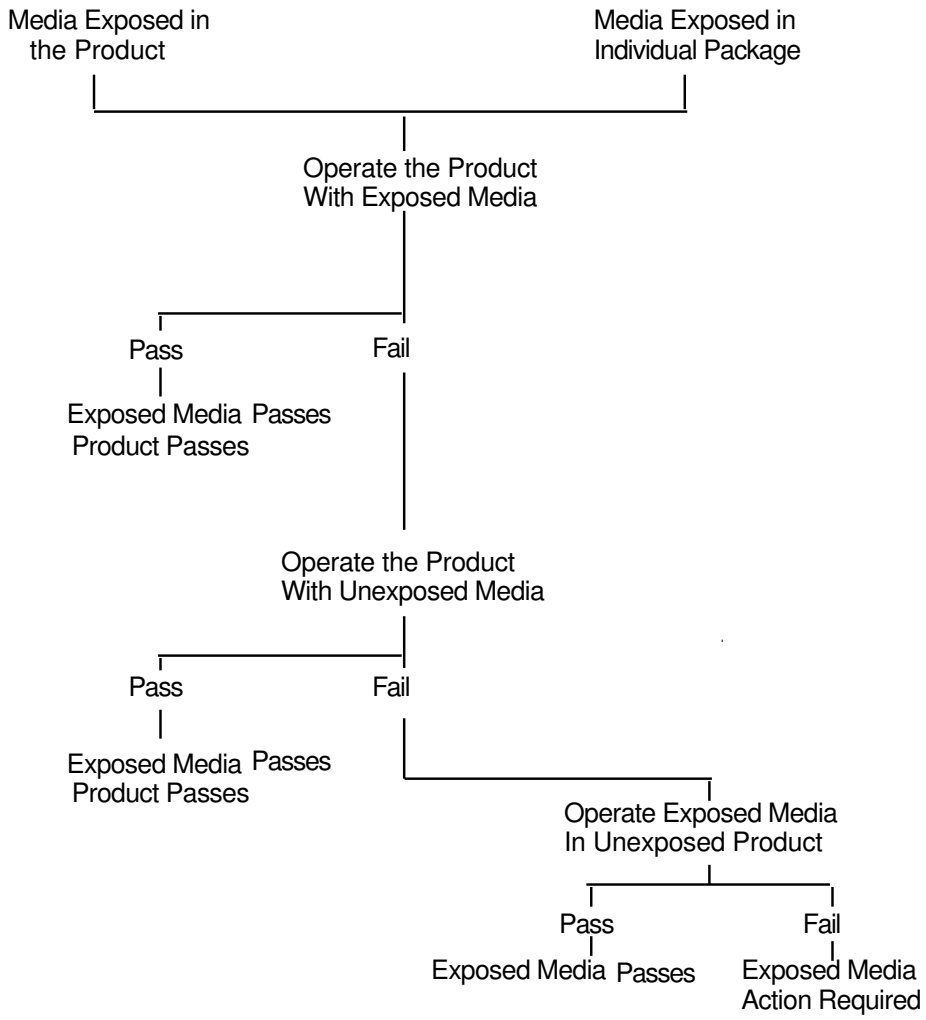
There are no requirements to obtain environmental data on or within the product except as required by individual test subheads or subhead 3.5.11, *Raw Data Requirements*.

3.5.5 Media Performance and Replacement

Media may be replaced during this Operating test only if the expected media life has been exceeded.

Media failure criteria and resolution procedure is defined in Figure 4.

Figure 4: Media Failure Criteria



NOTE

In Figure 4, *exposed* means subjected to the Nonoperating Vibration test.

3.5.6 Supplies and Expendables

Supplies and expendables may be replaced during Operating test programs only if their expected life or capacity has been exceeded.

3.5.7 Test Conditions

The Operating test environmental parameters are intended as input to the product structure. For tests in which the product is fastened to a rigid table or fixture, the specified acceleration parameters are to be achieved directly adjacent to the product mounting surface.

Any shock or vibration isolators intended primarily for protection from the shipping environment will be blocked out or suitably disabled for these operating vibration tests.

Any shipping brackets or shipping fasteners attached to the product for shipment will be removed for these tests.

3.5.8 Stabilized Test Conditions

Not applicable

3.5.9 Variable Voltage Tests

Not applicable

3.5.10 Rate of Change Limits

Not applicable

3.5.11 Raw Data Requirements

Input environmental parameter data may be required for Operating tests and the individual test section will define these requirements. Where required, the data shall be obtained at one of the following locations.

a. On the test table adjacent to a product mounting point

b. On the test fixture adjacent to a product mounting point

c. On the product cabinet at or adjacent to a mounting point

All control and response shock data such as photographs, recorder charts, and so on will be retained as part of the test data.

All product printouts or other product output media will be retained as part of the test data.

All notebook entries of chronological test events will be retained as part of the test data.

A photograph of a captured terminal screen is an acceptable way to retain the data.

3.5.12 Substitute Tests

Any test that meets all the criteria and specifications of these requirements will be acceptable, even if done in conjunction with other efforts. In all cases, this acceptance is contingent upon submittal of a complete formal test report defining all necessary parameters, results, and conclusions required by this standard.

3.5.13 Test Report Requirements

A formal test report is required to verify compliance with this standard. The test report must include all pertinent test data, identification, serial numbers, calibration dates of all test apparatus and equipment, and explicit identification of the product configuration tested, including the specific identification, serial numbers and revision level of all options and accessories. The test report must also identify the diagnostics or operational tasks used to verify product operation.

3.5.14 Test Apparatus Criteria

These requirements are defined in the individual test section. The test table or fixture used to transfer the specified inputs to the product must be rigid to minimize variations in actual input levels transmitted.

A formal calibration process must be maintained for all appropriate test and measurement equipment and proper calibration status must be maintained for equipment used in these tests.

3.6 DEC STD 102-2 NONOPERATING TESTS—GENERAL PROCEDURES

3.6.1 Test Samples

a. Number of samples required—Digital's criteria for approval of the product/shipping package is based on data from one to three separate packaged product tests.

   Each sample defined in those tests must successfully withstand the Nonoperating test exposures.

b. 50 Hz or 60 Hz test sample—Either test item is acceptable for these Nonoperating tests. It is not required to test each configuration unless physical differences exist that would warrant such testing.

c. Shipping packages and shipping materials—The shipping packages and shipping materials will be as specified for the product. Manufacturer's joint and closure of carton will be as specified in the appropriate packaging specification.

   All products, especially stand-alone products that are shipped on skids or on enclosure casters, will be tested using all protective packaging materials such as polyethylene bags, wraparounds, and desiccants specified for shipment of the product.

   Test packages that are shipped to the test laboratory site for testing must be over-cartoned to ensure arrival in perfect condition. New, unused shipping skids must be provided and used as specified for individual tests.

   Products that are packaged and shipped individually will be tested using the specific package, packaging materials, and procedures specified for the product.

d. Subassemblies or modules—Individual subassemblies and modules shall be tested and evaluated while installed in a host product. The host product chosen for these tests must represent the most demanding configuration expected of the subassembly or module.

   An individual subassembly or module may require environmental capabilities beyond those defined in this standard in order to accomplish specific operation in a host product. Specific individual subassembly and module requirements may vary due to physical differences among host products and mounting conditions.

   Tests to these requirements may also be used to evaluate individual customer shipping cartons for subassemblies and modules. In such cases, testing of the individual packaged items is justified.

   Media subassemblies or media and its associated hardware elements such as cassettes, cartridges, reels, disks, and floppies must be evaluated to these requirements. However, subsequent applications of media subassemblies, for various software or diagnostic

products for example, do not require additional testing unless the physical hardware element changes.

Manuals, books, drawings, and loose piece hardware, such as cables, connectors, screwdrivers, and so on, must be tested in cases where they are shipped within the product packaging, but individual packages for these items need not be tested separately.

Individual test sections may have additional requirements.

Any failures or defects experienced in the host product that are unrelated to the specific subassembly or module under test do not constitute a subassembly or module failure as long as the subassembly or module exhibits no damage and operates as required following the test exposure.

3.6.2 Product Operation

These tests are performed with the product in a nonoperating state, prepared for shipment according to the appropriate packaging instructions, and using the shipping package and materials specified for the product.

Product operation will be verified, before and after test exposure, by running a diagnostic routine or an actual operational task.

Successful product operation must be demonstrated before and after each Nonoperating tests according to specific procedures defined in each subhead. Some subheads require demonstration of performance after a test series, rather than after an individual test exposure. Test series refers to the entire sequence of a test. This does not preclude operational testing after each test.

The definition of hard errors and soft errors, as well as limits on these product errors, will be provided by the product group, in writing, before starting these tests. These documented error criteria will take precedence over the general criteria listed in the individual test sections of this standard.

When a part fails, such as a motor, bracket, or head, retests of the entire product is required.

Product printouts and any other output media records are to be retained and excerpts are to be included in the formal test report to document product operation. Passive items such as equipment slides, latches, card guides, covers, doors, and so forth, need to remain functional and operate as expected following the test exposure.

3.6.3 Adjustments to the Product

Operator adjustments to the product are acceptable.

Except where specifically noted within the individual test criteria, service type adjustments or replacement of any component, subassembly, or assembly of the product will require repeat of an entire Nonoperating test program.

Product operation must be verified before any disassembly of the product or before the product is opened for internal inspection.

3.6.4 Product Data Requirements

Environmental data may be required to identify the actual exposures occurring within the product as a result of these tests. Individual test sections contain necessary requirements.

3.6.5 Media Replacement

Media replacement is not allowed except as specifically defined in an individual test section or as specifically noted within the individual test criteria. Any necessary media replacement constitutes a failure and an entire repeat of the specific test program is required.

3.6.6 Supplies and Expendables

Replacement of any supplies or expendables are only allowed in order to replenish supplies depleted in the course of completing a diagnostic or operational run.

3.6.7 Test Conditions

Specific conditions are defined in the individual test sections.

3.6.8 Stabilized Test Conditions

Additional requirements may be defined in the individual test section.

All shipping packages and shipping materials should be preconditioned in the following temperature and humidity environment before these tests:

23°C ± 2°C (73°F ± 4°F) conditioning room control
50% ± 2% relative humidity (at the chamber or sensor)

Minimum conditioning time will be 5 hours for specimens of paperboard, fiberboard, corrugated board, or unsealed boxes and will be 16 hours for sealed fiberboard boxes. These tests are to be performed immediately upon removal from the conditioning environment, in cases where the test environment is different from the conditioning environment. Specimens requiring sealing or assembly using aqueous adhesives should be preconditioned after such sealing or assembly is completed.

These requirements are in accordance with ASTM D-685, *Standard Method of Conditioning Paper and Paper Products for Testing*.

The conditioning environment and the test laboratory conditions must be documented.

3.6.9 Variable Voltage Tests

Not applicable

3.6.10 Rate of Change Limits

Not applicable

3.6.11 Raw Data Requirements

Raw environmental data requirements are defined in the individual test sections.

All product printouts or other product output media will be retained as part of the test data.

All notebook entries of chronological test events will be retained as part of the test data.

A photograph of a captured terminal screen is an acceptable way to retain the data.

3.6.12 Substitute Tests

Any test that meets all the criteria and specifications of these requirements will be acceptable, even if done in conjunction with other efforts. In all cases, the approval of substitute tests is contingent upon submittal and acceptance of a complete formal test report defining all necessary parameters, results, and conclusions of the test required by this standard to the Environmental Engineering Group located at MLO6B-2/T13.

3.6.13 Test Report Requirements

A formal test report is required to verify compliance with this standard. The test report must include the following.

a. All pertinent and specified test data and observations, including calibration dates of all appropriate test apparatus and equipment.

b. Description of the product under test including model designations, serial numbers and other specific means of product identification.

c. Identification of the diagnostics or operational tasks used to verify product operation.

d. Description and dimensions of the container under test, its structural specifications, kind of material, description of blocking and cushioning, spacing, size and type of fastenings, method of closing and strapping if used, gross weight, special package identification numbers, and product orientation in the shipping package.

e. If package is preconditioned, report the temperature, relative humidity conditions, and duration of the conditioning.

f. Report the temperature and relative humidity conditions in the laboratory during actual testing.

g. Other details as specified in the individual test section.

3.6.14 Test Apparatus Criteria

Individual test sections define the apparatus criteria.

A formal calibration process must be maintained for all appropriate test and measurement equipment and proper calibration status must be maintained for equipment used in these tests.

3.7 PHYSICAL DEFECT DESCRIPTIONS

This section describes specific physical defects that products may experience during DEC STD 102-2 environmental tests.

The descriptions especially define occurrences that can be considered acceptable regarding DEC STD 102-2 compliance, and defects that must be considered unacceptable.

When a part fails, such as a motor, bracket, or head, a retest of the entire product is required.

Any hard or soft operational errors during post-test operational verification in excess of the failure criteria defined by the product group constitute failure.

Except for allowances specifically defined in an individual DEC STD 102-2 test section, (for example, Nonoperating Shock/Multiple Sample procedures), every product must emerge from each environmental test exposure without displaying any major physical failures or defects.

3.7.1 Major Defects

a. Cut wires

b. Broken fasteners, brackets, or component items

c. Permanent deformation of components or other items resulting in cracks or fractures of brackets, leads, or housings

d. Any operational abnormalities or failures, especially those that can result from:

   1. Loosening of particles or parts that could become lodged in circuits or mechanisms
   2. Intermittent electrical contacts
   3. Touching and shorting of electrical parts
   4. Misalignment of components, subassemblies, or adjustments

      Some minor cases of sliding misalignment of parts, such as adjacent enclosure elements, may not be considered a defect at all. Unless the misalignment is accompanied by breakage, unless the misalignment cannot be readily corrected (without tools), or unless the misalignment is so severe that it should be an obvious reason for failure, minor cases of sliding misalignment can be ignored.

      Except for doors or access panels, all product enclosure elements are expected to remain fastened during DEC STD 102-2 tests, and failure to remain fastened is considered a major defect. Cases where doors or access panels are discovered open after tests, such as Non-Operating packaged tests, are not considered minor defects.

   5. Interference between parts

e. Product stops and cannot be restarted with normal operator procedures

f. Printer product skips one or more characters

g. Printer characters are blurred beyond recognition

h. Released or loose modules, connectors, or other items

i. Any visible external damage, including wear of external parts

Wear of exterior surfaces of a product is normally an appearance issue, but there may be instances of severe wear that affect operation of the product.

The following wear defects are considered major:

— Any wear that prevents or hinders normal operation of any part of a product, such as wear on the surface of a viewing window or cases where wear debris prevents operation of mechanical parts, such as switches, and so on.

— Generation of large amounts of wear debris. While a thin dusting of wear particles may be acceptable, a *pile* of debris is not acceptable.

— Generation of any visible wear debris that cannot be easily and quickly removed from the product.

— Clearly evident scratches or other wear tracks on exterior surfaces.

— Visible wear (after removal of debris) on an area critical to the appearance of the product.

— Any case of wear completely through a plastic bag, or other material creating a protective barrier in contact with the product in the shipping package. It is unacceptable to wear completely through protective barrier material in contact with the product in the shipping package if the performance of the barrier is significantly diminished.

  Wearing through or puncturing bags used for protection from moisture is unacceptable because holes in such barriers will seriously reduce the protection they were intended to provide. Small holes are acceptable in bags which provide ESD protection, but large holes are not acceptable. For polyethylene-type bags that are used only as dust covers, some holes are allowed as long as the basic protective function remains essentially intact.

j. Wear of internal parts or joints

Wear of internal parts may result in unacceptable appearance, in unacceptable safety or reduced reliability, and in unacceptable degradation of EMI shielding performance. Disagreements about whether the amount of dusting or debris observed in a test is acceptable will be elevated to the DEC STD 102 Advisory Committee for resolution.

Large amounts of wear debris generated within the product enclosure but visible outside the enclosure are not acceptable. Light or moderate dusting on the product surface, which can be easily removed, is acceptable.

The presence of loose conductive particles within the product will be evaluated by visual inspection of the enclosure interior. While no precise pass/fail criteria can be applied, generation of appreciable amounts of loose, electrically conductive particles inside the product is not acceptable.

Loose flakes, slivers, or sheets of conductive materials (metals, plating , conductive paints, and so on) are unacceptable. Depending on the amount and size of the particles, small amounts of dust that may be conductive may be acceptable. The presence of any conductive particles presents a risk and should be evaluated on a case-by-case basis.

EMI shielding may be degraded by loss of conductive material or by build up of nonconductive material. A small amount of visible wear and generation of wear particles are allowed at gasketed joints, and so on, if EMI shielding remains adequate. Wear particles generally increase electrical resistance of the gasketed joints, degrading shield performance.

If the amount of wear debris generated raises concern about EMI performance of the enclosure, such performance should be evaluated with an EMC scan. Wearing completely through the protective plating at a joint is generally not acceptable because it leads to loss of electrical continuity in the shield . Such wear at localized spots may be allowed if the maximum length of the gaps generated remains less than the allowable gap specified by the responsible EMC engineer.

k. Loss of containment due to partial or total failure of the shipping package resulting in a visible or exposed part of the product.

l. Damage to shipping materials that could prevent safe handling or safe storage, such as broken bottom deck boards on skids, broken skid deck or stringer, crushed or damaged packages that indicate obvious stacking questions.

m. Extensive disintegration or separation of cushioning materials that eliminate indexing or positioning of the product within the container.

3.7.2 Minor Defects

The following conditions may be considered *minor defects* to the extent the occurrence is in fact negligible. As long as the operational performance of the product has remained satisfactory, the implications of the following items may be minor with regard to product acceptance.

Consideration must be given this effect affecting operation, aesthetics and cosmetic impact, structural integrity, and physical interference of service and operation. Minor defects include:

a. Pinching or chaffing of wires or finishes.

b. Bending of fasteners, brackets, or component items.

c. Debris or particles within the product that are less severe than the major defect defined.

d. Wear of external surfaces. Small amounts of chafing debris on or near the external surface of an enclosure that can be readily and easily removed are acceptable. Also acceptable is minor evidence of wear, chafing, or scratching on an external surface that can only be seen by examination from a distance closer than 0.5 meter.

e. Printer characters blurred but recognizable according to the product criteria.

f. Open or misaligned enclosure panels.

Some minor cases of sliding misalignment of parts, such as adjacent enclosure elements, may not be considered a defect. Unless the misalignment is accompanied by breakage, unless the misalignment can not be readily corrected (without tools), or unless the misalignment is so severe that it should be an obvious reason for failure, minor cases of sliding misalignment can be ignored. Except for doors or access panels, all product enclosure elements are expected to remain fastened during DEC STD 102-2

tests, and failure to remain fastened is considered a major defect. Cases where doors or access panels are discovered open after testing, such as Nonoperating Packaged tests, are not considered minor defects.

In all cases, document in the test report the description of the observed defect, its major or minor classification and the resulting pass or fail judgment.

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